LEAST SIGNIFICANT BIT STEGANOGRAPHY TECHNIQUE USING MODULUS OPERATION WITH PIXEL GROUPING SELECTION DERIVED FROM K-MAP AND GAUSSIAN ELIMINATION

SAYUTHI BIN JAAFAR

UNIVERSITI TEKNOLOGI MALAYSIA

LEAST SIGNIFICANT BIT STEGANOGRAPHY TECHNIQUE USING MODULUS OPERATION WITH PIXEL SELECTION DERIVED FROM K-MAP AND GAUSSIAN ELIMINATION

SAYUTHI BIN JAAFAR

A thesis submitted in fulfilment of the
requirements for the award of the degree of
Doctor of Philosophy (Computer Science)

Faculty of Computer Science and Information Systems
Universiti Teknologi Malaysia

JANUARY 2013

To my beloved wife, sons and daugthters

ACKNOWLEDGEMENT

Alhamdulillah, the utmost gratitude I express to my dearest God, Allah SWT, for bestowing upon me the greatest strength, patience, courage, and determination in finishing this work.

I also wish to express my sincere gratitude and appreciation to my supervisor, Professor Dr. Azizah binti Abdul Manaf, for her never-ending encouragement and support as well as her invaluable guidance towards the success of this research. All of the regular sessions that we have had through out the period of study have proved to be a fruitful effort as the sessions do contribute tremendously to the success of the research.

I am also very grateful to Prof. Dr. Richard Eason from University of Maine, USA, for providing me with accomodation in his faculty for three months. Your support, idea and comment really showed me the right track in persuing this research.

I also want to thank all of my friends for their support and help; and not forgetting their view and tips, both are very useful indeed. Unfortunately, it is not possible to list all of them in this limited space.

Last but not least, I would also like to express my high gratitude to all my family members. My deepest feelings go to my beloved wife, sons and daughters for giving full support, aspiration and high understanding during the period of my studies.

ABSTRACT

As demand for information exchange across the network increases, so is the need for safe covert communication, which can be achieved using steganography. Many steganography techniques have emerged; however the performance of the techniques rely heavily on three major factors, which are the payload, imperceptibility and robustness. These elements are always in trade-off. In this research, a new steganography technique that emphasizes on high imperceptiblity with reasonable embedded capacity is presented. The proposed embedding approach leverages on the LSB substitution technique and neighbourhood operation to precisely determine how much changes is required for each target pixel of host image in terms of its gray scale. Thus, a 9x9 filter called Matrix Distribution Array (MDA) is introduced based on the Karnaugh Map grouping principle to generate nine possible 4-pixel groups for pixels selection. A modulus operation is then performed for each group to obtain a group residue (Res). An initial change of the target pixel value is calculated based on the difference between Res and secret information. Afterwards, the Gaussian Ellimination technique is then applied together with MDA on the change value to obtain a final figure of the change required. Finally, the target pixel is modified and rounded accordingly by subtracting its original gray scale with the change value. The embedding process is repeated until a stego-image is eventually produced, likewise, an extraction process is performed using a similar procedure but in a reverse manner. The experimental results show that the imperceptibility of the proposed method improved significantly by 8% to 16% when tested with fixed embedding capacity ranging from 6 kB to 116 kB as compared to the LSB substitution technique. The result also reveals that the embedding capacity improves up to 50% while maintaining reasonable Peak Signal-to-Noise-Ratio (PSNR) value between 35dB to 40dB.

ABSTRAK

Peningkatan permintaan pertukaran maklumat merentasi jaringan secara berterusan adalah selari dengan keperluan komunikasi rahsia yang selamat yang mana boleh dicapai melalui teknik steganografi. Walaupun terdapat banyak teknik steganografi yang telah diperkenalkan, prestasinya amat bergantung kepada tiga faktor utama, iaitu kapasiti, ketidakbolehnampakan, dan kekukuhan. Ketiga-tiga faktor ini saling bergantung diantara satu sama lain. Dalam kajian ini, satu teknik steganografi baru yang memberi penekanan terhadap pencapaian ketidakbolehnampakkan yang tinggi dengan kapasiti pembenaman yang berpatutan dikemukakan. Pendekatan cadangan adalah lanjutan daripada teknik penggantian Bit Bererti Terkecil (BBT) dengan penambahbaikan melalui operasi kejiranan antara piksel-piksel yang dipilih. Ianya akan menentukan dengan tepat perubahan yang diperlukan untuk setiap sasaran piksel imej hos dari segi nilai skala kelabu. Sehubungan dengan itu, satu penapis 9x9 yang digelar sebagai Matrik Tatasusunan Taburan (MTT) yang berasaskan kepada prinsip perkumpulan Peta Karnaugh diperkenalkan untuk menjana sembilan kemungkinan kumpulan yang bersais 4 piksel setiap satu. Seterusnya, operasi modulus dilakukan terhadap setiap kumpulan untuk mendapatkan nilai sisa berkumpulan. Perubahan awal terhadap piksel sasaran dikira berdasarkan perbezaan diantara sisa tersebut dengan maklumat rahsia. Berikutnya, teknik Penghapusan Gaussian digunakan bersama dengan penapis MTT terhadap nilai perubahan tersebut untuk mendapatkan nilai perubahan sebenar piksel sasaran. Akhirnya, nilai asal piksel sasaran ditolak dengan nilai perubahan sebenar diatas untuk menghasilkan skala kelabu yang baru, dan seterusnya nilai tersebut dibulatkan sewajarnya. Proses pembenaman ini diulangi sehingga imej-stego keseluruhan dihasilkan. Sedemikian juga dengan proses pengekstrakan, ianya dilaksanakan dengan menggunakan prosedur yang sama tetapi dalam keadaan menyongsang. Keputusan eksperimen menunjukkan bahawa ketidakbolehnampakkan meningkat dengan ketaranya berbanding dengan teknik penggantian BBT, iaitu sebanyak 8% hingga 16% apabila diuji dengan kapasiti pembenaman yang ditetapkan daripada 6 kB hingga 116 kB. Hasil ujian juga menunjukkan bahawa kapasiti pembenaman meningkat sehingga 50% untuk nilai Puncak Nisbah-Isyarat-terhadap-Hingar (PNIH) antara 35dB hingga 40dB.